AD-A258 698

2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
October 1992	final technical report 11/1/90-4/30/92

4. TITLE AND SUBTITLE
"Anytime Declarativism" (2)

5. FUNDING NUMBERS
G: AFOSR-90-0363
WRDC595400
613012
(2)

6. AUTHOR(S)
Matthew L. Ginsberg
Nils J. Nilsson

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Computer Science Department
Stanford University
Stanford, CA 94305

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
AFOSR/NM
Building 410
Bolling AFB, D.C. 20332-6448

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
AFOSR-90-0363

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release: distribution unlimited.

12b. DISTRIBUTION CODE
UL

13. ABSTRACT *(Maximum 200 words)*

The objectives of this grant is to formalize the notion of anytime inference. This work consisted of an extension to Ginsberg's work on multivalued logics, since this earlier work allows arbitrarily finely grained responses to declarative queries. They will also develop a procedure that responds to a declarative query in an anytime fashion, in that it returns the correct answer in the large runtime limit but only approximate answers in shorter times. Both uniform and nonuniform convergence will be addressed.

14. SUBJECT TERMS	15. NUMBER OF PAGES
	3
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UL	UL	UL	UL

Anytime Declarativism: Final Report

AFOSR-90-0363
1 NOV 90 - 30 APR 92

Matthew L. Ginsberg
Nils J. Nilsson

Computer Science Department
Stanford University
Stanford, California 94305
ginsberg@cs.stanford.edu

Names and phone numbers of key Stanford personnel:

Technical:	Matthew L. Ginsberg	415-723-1239
	Nils J. Nilsson	415-723-3886
Business:	Cornelia Shonkwiler	415-723-2633

1 Objectives and status

The following objectives are repeated from the original statement of work:

- Formalize the notion of anytime inference. This work will consist of an extension to Ginsberg's work on multivalued logics, since this earlier work allows arbitrarily finely grained responses to declarative queries. We will also develop a procedure that responds to a declarative query in an anytime fashion, in that it returns the correct answer in the large runtime limit but only approximate answers in shorter times. Both uniform and nonuniform convergence will be addressed.

  Status Completed. The formalization involved generalizing the notion of a modal operator [2], and the algorithm was described in [3] and [4]. The nature of the convergence of this algorithm led to a variety of interesting results described in [7].

- Implement the formalization developed above. Once again, we will proceed by extending the existing implementation of multivalued logics. We hope to include both facilities to interrupt the inference procedure at an arbitrary time, and for the procedure to stop and return (in a resumable state) as soon as it obtains an approximate answer that meets user-supplied "validity" requirements. If sufficient progress has been made in areas supported by other agencies, we will apply the implemented system to the solution of a simple planning problem in a real-time environment.

  Status Completed. The results were implemented and included in the MVL theorem-proving system [1, 5]. The use of the system to develop a real-time planning system is described in [6] and [7].

References

[1] M. L. Ginsberg. User's guide to the MVL system. Technical report, Stanford University, 1989.

[2] M. L. Ginsberg. Bilattices and modal operators. *Journal of Logic and Computation*, 1:41–69, 1990.

[3] M. L. Ginsberg. Anytime declarativism. Technical report, Stanford University, 1991.

[4] M. L. Ginsberg. Computational considerations in reasoning about action. In *Proceedings of the Second International Conference on Principles of Knowledge Representation and Reasoning*, Boston, MA, 1991.

[5] M. L. Ginsberg. The MVL theorem proving system. *SIGART Bulletin*, 2(3):57–60, 1991.

[6] M. L. Ginsberg. First-principles planning and the Holy Grail. Technical report, Stanford University, 1992.

[7] M. L. Ginsberg. Modality: The key to practical knowledge representation. Technical report, Stanford University, 1992.

2 Journal publications

- "Modality: The key to practical knowledge representation," to be submitted to *Artificial Intelligence* or similar journal
- "Prolegomena to any future prolegomena," invited reply to Sacks and Doyle's paper, "Prolegomena to any future qualitative physics," *Computational Intelligence* **8** (1992) 253–256
- "Iterative broadening," with W.D. Harvey, *Artificial Intelligence* **55** (1992) 367–383
- "Knowledge Interchange Format: The KIF of Death," *AI Magazine* **12** (Fall, 1991) 57–63
- Invited review of *The Society of Mind*, *Artificial Intelligence* **48** (1991) 335–339
- "The MVL reasoning system," SIGART Bulletin **2**, No. 3 (1991) 57–60
- "Negative subgoals with free variables," *Journal of Logic Programming* **11** (1991) 271–293
- "Bilattices and modal operators," *Journal of Logic and Computation* **1** (1990) 41–69

3 Personnel

- Matthew L. Ginsberg (senior research associate)
- William Harvey (fellowship supplement)
- Adnan Darwiche (research assistantship, Ph.D. expected 1992, *Belief Systems and Conditionalization*)
- Hugh Holbrook (research assistantship)

4 Interactions

4.1 Conference and workshop papers

- "What defaults can do that hierarchies can't," with H.W. Holbrook, Fourth International Workshop on Nonmonotonic Reasoning (1992)

- "A symbolic generalization of probability theory," with A.Y. Darwiche. *AAAI-92*
- "Is there any need for domain-dependent control information?" with D. Geddis. *AAAI-91*
- "Computational considerations in reasoning about action," *KR-91*
- "The computational value of nonmonotonic reasoning," *KR-91*

4.2 Related work

DARPA/Rome Labs-supported work on transportation planning initiative. The ideas developed under this AFOSR award substantially improved our ability to understand the more specific planning problems involved in transportation planning. As remarked in Section 1, the planning work provided us with a specific domain in which our real-time ideas could be tested and demonstrated.